Fast laser cutting with highly dynamic beam deflection optics

Task

Laser cutting processes are widely used in today's manufacturing industry. However, in particular when cutting contours, the high-speed cutting potential of the laser is in many cases not fully utilized due to limited dynamics of the cutting machines. Modern fiber and disk lasers with higher brilliance make this discrepancy even more obvious. This is especially evident in the field of cutting thin and medium thick sheet metal. Solutions are sought that utilize the laser beam along the cutting contour at speeds that correspond to its cutting capability. Simultaneously, cutting precision and edge quality have to be maintained.

Solution

The solution to this problem is to integrate additional motion axes into the laser cutting head, which take over the highly dynamic motion of the laser beam during phases of high acceleration and jerks while the main machine performs a simplified motion path for the laser head. The superposition of the motion ranges of the main (yellow in Fig. 2) and additional head axes (red in Fig. 2) allow positioning of the laser spot quickly at any desired location. An intelligent planning algorithm considers all conditions such as working field dimensions, jerks, acceleration and speed for main and additional axes and determines a motion path that minimizes the cycle time.

Results

IWS engineers developed the 2D beam deflection optics for the processing head. This optics synchronizes the laser beam with a separately driven cutting gas nozzle. Nozzle and laser beam move highly dynamically close to the process. Splitting up the motion of laser beam and gas jet reduces the required weight for each additional axis to less than 300 g. Subsequently the drastically reduced inertia of the additional axes allows accelerations of 80 m s^{-2}.

A prototype was developed to evaluate the system and technological limitations of this concept. Processing time savings of more than 60 % were demonstrated for complex cutting geometries if compared to conventional cutting without additional axes. Simultaneously, it was also observed that this method significantly relieved the main machine axes.

The application of this solution makes sense where sheet metal of average thickness (1 – 5 mm) has to be cut into complex shapes at great flexibility and high productivity. An example is the manufacturing of stator and rotor segments for motors and generators. Here the method offers an alternative to the highly productive but inflexible stamping or flexible but slow conventional laser cutting processes.

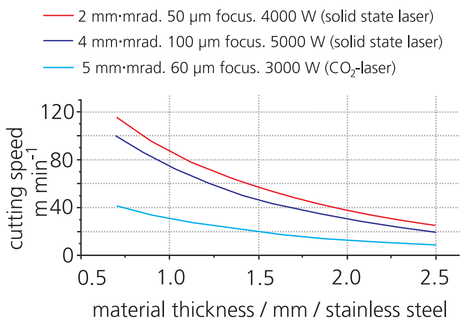

Fig. 1: Cutting speeds as a function of material thickness and laser type (straight cut)

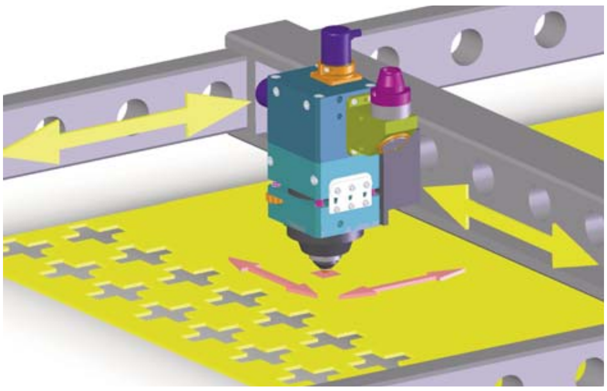

Fig. 2: CAD model of the coupled axes system (yellow: main axes, red: additional axes)

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